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ABSTRACT

A model incorporating both academic and nonacademic factors as determinants of productivity was tested with samples of physical and biological scientists, social scientists, and humanists taken from the 1972-73 American Council on Education survey of faculty at U.S. institutions of higher learning. Considerable variation was found in the process determining productivity both across the broad disciplinary categories as well as within categories when article and book productivity are compared. The relative influence of the disciplinary content and attributes of scholars on productivity was also examined. The analysis considered 17,399 faculty holding conventional appointments at universities or four-year colleges. The gender, race, marital status, and socioeconomic status of scholars were included in the analysis along with the following academic characteristics: years of experience, academic rank, tenure status, doctoral degree, time involved in obtaining this degree, number of grants received, and measures of commitment to research versus teaching. It is suggested that the decisive edge that physical and biological scientists enjoy over social scientists and humanists in article productivity is largely the result of the nature of work or a favorable disciplinary milieu, while the lower rate of productivity among humanists is more heavily determined by their attributes. References are included. (SW)

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RESEARCH PRODUCTIVITY IN ACADEMIA: A COMPARATIVE STUDY OF THE SCIENCES, SOCIAL SCIENCES AND HUMANITIES*

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RESEARCH PRODUCTIVITY IN ACADEMIA: A COMPARATIVE STUDY OF THE SCIENCES, SOCIAL SCIENCES, AND HUMANITIES

ABSTRACT

Though a significant number of studies of scholarly productivity have accumulated in the past decade, the majority have focused on limited samples of specialists in one or only a few scientific disciplines, making it difficult to generalize findings across dissimilar academic disciplines. This paper tests a model incorporating both academic and nonacademic factors as determinants of productivity with samples of physical and biological scientists, social scientists, and humanists taken from the 1972-73 American Council on Education survey of faculty at U.S. institutions of higher learning. We find considerable variation in the process determining productivity both across the broad disciplinary categories as well as within categories when article and book productivity are compared. We also examine the relative influence of the disciplinary context and attributes of scholars on productivity. Our evidence suggests that the decisive edge that physical and biological scientists enjoy over social scientists and humanists in article productivity is largely the result of the nature of work or a favorable disciplinary milieu, while the lower rate of productivity among humanists is more heavily determined by their attributes.

INTRODUCTION

Over the last decade a significant number of studies of scholarly productivity -- the publication of articles and books -- have begun to accumulate. Most of this work continues in the tradition of, and is ably built upon, research that began in the 1940's. The extent of its development -- from Meltzer's (1949) and Manis' (1951) findings of consistent relationships between measures of professional performance and publication to Long's (1978) use of a longitudinal design and regression analysis for examining the reciprocal effects of departmental location and scientific productivity -- is most evident.

As analysts have become increasingly specialized in the sociology of science, most research on productivity has been increasingly restricted to samples of scientists. Often, studies have focused on limited numbers of specialists in one or only a few scientific disciplines. The research productivity of social scientists, for example, has been less frequently studied, while that of humanists has seldom been examined, and only as part of a larger sample of university faculty. Such use of restricted, homogeneous samples for analysis may have moderated the development of the field.

The interest among current researchers in the careers of scientists and not those of the professoriate (although these obviously are not isomorphic, some publications treat them as such) has not led to adequate comparisions among scientists, social scientists and humanists. Over 30 years ago, Meltzer observed that for research on scholarly productivity there is "wisdom in treating each discipline...separately" (1948:29).

While detailed comparisions such as Meltzer might envision may not be necessary, it would certainly be useful to know if models accounting for research productivity in one context could be extended to other areas of academia. In order to further our understanding of scholarly productivity in the broadest sense, an analysis of the subject that includes these three disciplinary categories now seems in order. As presently developed, the sociology of science offers a few clues as to how closely a model predicting research productivity for humanists would approximate one for natural scientists or social scientists. These we will utilize in the next section to develop some tentative hypotheses concerning differences across these broad disciplinary categories.

THE DISCIPLINARY CONTEXT AND SCHOLARLY PRODUCTIVITY

It is a commonplace that consensus over issues of theory and methodology is greater in the sciences than in the humanities (Kuhn, 1970). The presumed existence of a scientific paradigm implies that the mission and methods of inquiry are clearly understood and given tacit acceptance by those within the scientific community. Such shared beliefs typically encompass the theoretical principles of a discipline, as well as its research priorities (i.e. the designation of solvable problems) and its classification of facts by which the order of things is explained.

Lodahl and Gordon (1972), in a comparison of physics, chemistry, sociology, and political science, show that scientific fields with better developed paradigms have more structure and predictability in their teaching and research activities. On the basis of this predictability

alone we should anticipate greater productivity in the natural sciences, since a higher proportion of their research is presumably along established lines. Also, to the extent that the greater agreement on basic principles in fields with a higher level of paradigm development has consequences for the reward system -- the more consensus, the more efficient the reward system (Zuckerman and Merton, 1972) -- then Allison and Stewart's (1974) findings that rewards affect productivity suggest that research productivity might be quite different in the natural sciences, social sciences and humanities. The existence of a well-developed paradigm in an intellectual field should also indirectly influence productivity by enhancing (or restricting) opportunities for publication. In fact Zuckerman and Merton (1971) found that the rejection rate of manuscripts submitted to journals was highest in the humanities, lower in the social sciences, and lowest in the physical, chemical, and biological sciences.

Collins (1975) argues that the paradigm-nonparadigm distinction alone is inadequate to characterize the social structure of intellectual fields and its consequences for their advance. Viewing the intellectual world from a formal organizational perspective, he suggests that fields vary particularly in terms of the degree of uncertainty in their task outcomes, which is largely a function of their degree of paradigm development and standardization of research methodology, and the degree to which problems of coordination arise from the need to organize separate tasks, workers, or work places. According to Collins, coordination in intellectual fields refers to the degree to which intellectuals must rely on colleagues to have successful careers and

varies with (a) the extent to which they must communicate only with other intellectual specialists, as opposed to external audiences; (b) the absolute number of workers competing in the field; (c) dependence of their work on material resources; and (d) the scope of intellectual problems as it affects the number of investigators required to solve them (1975: 508).

As in the case of the degree of paradigm development, the degree to which coordination problems arise in intellectual fields has a number of direct implications for productivity. Research in the natural sciences is often carried out by teams requiring substantial funding for equipment and support personnel, while in the humanities, scholars commonly work alone, needing only books and little else in the form of capital investment. (Some work in the social sciences most closely resembles the former style, while some is in the tradition of the humanities.) As a result, we would anticipate that factors such as the number of research grants awarded a scholar to have a stronger effect on productivity in the natural sciences, as would the prevalence of post-doctoral training, the source of much of the manpower in team research. Likewise, the quality of instutional affiliation is more likely to affect productivity among natural scientists to the extent that such quality is reflected in the greater availability of material resources.

Collins' (1975) list of factors influencing the degree of coordination required in intellectual fields also suggests that we must consider the mode, as well as the process, of communication in comparing these disciplinary categories. In particular, the most important results of research in the natural sciences are reported in articles, where references to formulae, equations, and the like significantly reduce

manuscript length. On the other hand, books, often directed to an external audience as well as a scholarly audience, provide a significant outlet for the results of scholarship in the humanities and social sciences. Such discrepancies in the format and length of reported research could well be reflected in differences in content. Replications of data-based research and the publication of negative findings are both more prevalent in the natural sciences. In most studies we reviewed, research productivity is measured in terms of quality or quantity of articles or by an index combining articles and books. Little attention has been paid to book productivity and its determinants among natural scientists and even less to writers in other fields. In our analysis, we will not assume that factors influencing article and book publication are identical, and therefore will not utilize a composite index of productivity. Instead, we will perform separate but parallel analyses of article and book productivity, both within and across disciplinary categories.

A GENERAL MODEL OF PRODUCTIVITY

Essential to testing questions like those posed above is a model incorporating the determinants of productivity that can be used to compare effects across disciplinary categories. Suggested explanations of differential research productivity have emphasized both personal attributes of the scholar (e.g., natural ability, commitment to research) and the dynamics of professional life (e.g., the superiority of some graduate training programs, the influence of sponsorship, the stratification of the academic profession). Despite the acquisition of abundant data and sophisticated research designs there is really little consensus regarding

the determinants of scholarly productivity. As one instance, writers disagree about the impact of graduate training on the production of scientific work. The direct relationship which Crane posits between the quality of graduate training and later productivity (1965: 703-704) finds support elsewhere in the literature (Lightfield, 1971), while Clemente and Sturgis, on the other hand, observed only a weak relationship between these measures (1974: 295), and Gaston found almost none (1970: 721). Similar incongruities pertaining to the effects of gender, time to acquire a Ph.D., experience and the quality of institutional affiliation are evident in the literature. For example, Cole and Cole use cross-sectional data on 120 American physicists to demonstrate a statistically significant correlation (r=.24) between the quality of academic positions and productivity (1967: 385). Gaston derived an identical correlation between these measures for his sample of British physicists, but concluded that "the prestige of a scientist's current affiliation has only a negligible -- if any -- effect on his productivity" (1970: 721).

We have neither the intent nor capacity to assess the relative strengths of particular theoretical or analytic schemes. Our data, cross-sectional in nature and further constrained by its use in secondary analysis, is unsuited for such questions. To explore the contrasts between disciplinary categories, we do propose a composite model of productivity that incorporates several prominent themes and important variables contained in the major studies of academic productivity, regardless of what perspective they appear to support. These studies suggest a number of variables that should be considered for inclusion in formulating an empirical model of scholarly productivity.

The studies that we have reviewed and from which our model is developed point to several questions that must be addressed if we are to further our understanding of scholarly productivity. First of all, they make it clear that we must explicitly separate explanatory factors into two major domains: background characteristics, such as sex or socioeconomic origins, and the features of the academic career, such as rank or quality of institution. Much research by sociologists has either ignored background factors or concentrated on just one or two of them. If in fact these characteristics have a major impact on scholarly productivity, a serious specification error affecting the relationship between academic factors and productivity is committed by ignoring them. For purposes of this analysis we presume that the background characteristics are antecedent to the academic factors, making it possible to determine the extent to which they have both direct and indirect effects on scholarly productivity. Beyond this, our data does not permit further ordering of causal factors and we limit our analysis and interpretations accordingly. Second, it is important to separate the effects of disciplinary context from those of the the attributes of scholars within disciplines. This we attempt to achieve by means of a standardization procedure elaborated below. At the heart of our inquiry, however, is the assumption that the process whereby backgrounds, motivations, and resources are transformed into scholarly productivity varies systematically across the natural sciences, social sciences, and humanities.

As will become quite clear from the brief review that follows, diverse theoretical and empirical models have precluded the development of a singular perspective for understanding academic productivity. Using

a sample of 266 social scientists, Meltzer (1949) observed that signs of early productivity (age at Ph.D. and first publication), as well as rapid completion of graduate training were directly associated with career productivity. The proposition that early performance is a strong predictor of productivity in later years is generally supported by Cole and Cole (1967: 388), Clemente (1967: 415), Clemente and Sturgis (1974: 292), Long (1978: 898) and Long, et. al. (1979: 826). On the other hand, Reskin studied 238 chemists and observed that "early productivity did not significantly affect decade output," nor did the time it took to complete a Ph.D. (1977: 500).

These studies (with the exception of Reskin, 1977) implicitly support the "sacred spark" thesis of productivity (Cole and Cole, 1973: 114) which holds that differences in ability, motivation, stamina and attitude predispose certain individuals toward research endeavors which, in turn, contribute to their productivity. Accordingly, general commitment to research in the form of psychological dispositions and/or exaggerated work routines is a key explanatory variable in many such accounts (Aran and Ben-David, 1968; Simon, 1974; Gaston, 1970: 721; Hargens, 1978: 103). Since most studies of productivity have been carried out by sociologists of science, the overall homogeneity of the scientific community with respect to ascriptive characteristics that are often sociologically relevant (e.g. gender and race) has unfortunately limited inquiry into the impact of these variables on productivity, though some studies have examined the question. Babchuk and Bates concluded that "women were far less prolific than men," a condition attributed to the formers' "apparent lesser orientation to the discipline" (1962: 347). The majority

of studies not excluding women from the analysis, however, found gender to be unrelated to productivity (Simon et al., 1967; Clemente, 1973; Clemente and Sturgis, 1974; Reskin, 1978), although Hargens found that "male research chemists published more than females" (1978: 158).

Extending the sacred spark perspective further, Crane presents data which suggests that the relationship between institutional affiliation and productivity is mediated by the quality of graduate training (1965: 704). Crane reasons that the most capable individuals come to attend the best graduate programs and through a process of increasing selectivity, gain sponsorship from top scientists, appointments to major universities, and eventually "become the next generation's most productive scientists" (1965: 705).

While theories of natural ability such as Crane's presume a clear and direct relationship between individual and performance differences, advocates of what has come to be known as the "accumulative advantage" framework recognize the reciprocal effects of material and symbolic factors upon productivity. Here it is argued that because scholarly productivity results in differential recognition, it, in turn, functions to motivate as well as to furnish various resources that will facilitate later research. Manis first observed that the quality of an individual's institutional affiliation was directly related to the quality of scholarly productivity (1951: 270), a finding indicative of the contextual effect of institutional setting upon performance. Babchuk and Bates likewise conclude that "generally, the more prolific sociologists were affiliated with major universities" (1962: 347).

Reskin's use of a longitudinal design, which represents a substantial

advancement over previous methods, suggests that "beginning one's career in a university was a far more important determinant of decade productivity than one's graduate school credentials" (1977: 499), particularly, it seems, for women (1978: 1239). Substantially identical conclusions were drawn by Long (1978), who emphasized that disparities in productivity among biochemists are in fact accentuated when such effects as the quality of an individual's Ph.D. sponsorship and individual prestige are controlled.

This body of research then, may not provide a consistent picture, but it does offer a theoretical framework as well as an empirical tradition which suggests the contours of a general model of productivity that can be utilized to make the comparisons across disciplinary categories that are central to our research.

DATA AND MEASURES

The data to be analyzed were gathered during the 1972-73 academic year by the American Council on Education (ACE). A four-page questionnaire was mailed to a stratified sample of 108,722 faculty teaching in 301 American institutions of higher learning, yielding 53,034 usable responses.[1] The sample included faculty from 78 universities, 181 four-year colleges, and 42 junior or community colleges. Our analysis is restricted to 17,399 individuals (33% of total sample) holding conventional appointments at universities or four-year colleges. We assume that there is little expectation that faculty at two-year institutions produce or publish scholarly work, and therefore they are excluded from the analysis.

Three subsamples are identified by aggregating specific disciplines

into broad disciplinary categories: the physical and biological sciences, the social sciences, and the humanities. Individuals designated as physical and biological scientists (39%) are found in departments of chemistry, earth science, physics, biology, bacteriology, molecular biology, virology, microbiology, biochemistry, botany, zoology and physiology or anatomy. Social scientists (24%) hold appointments in departments of anthropology, psychology, archaeology, economics, political science or government, sociology or social psychology, while humanists (37%) are in departments of English language and literature, foreign language and literature, history, philosophy and religion or theology. Faculty in the performing or studio arts and in professional schools are excluded from the analysis since the norms of scholarly performance as well as the product of such performance often differs in these settings. Since our primary objective is to examine the extent to which the determinants of productivity and their effects differ among the much studied "hard" scientific disciplines, the social sciences, and humanities, such gross categorization is adequate at this stage of inquiry. As we learn more about the distinctions both between and within these groups, more precise specification may be warranted. We recognize, for example, that important differences exist among the physical and biological sciences regarding determinants of productivity (Allison and Stewart, 1974). We assume, however, that disciplines within disciplinary categories share a great deal in common with respect to the prevailing technical, social and normative conditions of their work.

The specific dependent measures to which attention is given are the self-reported number of articles and books published by individual

faculty members. In the minds of many, such a crude measure of productivity might leave something to be desired. In particular, there are no safeguards built into the ACE data to check the accuracy of self-reports. These data on research productivity, moreover, fail to ascertain the relative quality of work, asking only for simple counts of articles and books. However, it is a commonplace that the vast majority of sociological research is based on responses to survey items asking respondents to report on their own backgrounds, attitudes and behaviors. To rule out self-reported data would be to eliminate most sociological research. It should also be pointed out that, while their reliability is likely superior to that of self-reported counts, publication counts based upon available indexes and abstracts are not without error (see Hargens et al, 1976). In any case our interest here is upon comparisons across disciplinary categories, and it is unlikely that what measurement error exists is correlated with discipline, i.e. it is implausible that sociologists are any more likely to misrepresent their publication counts than chemists.

As has been frequently observed (Bayer and Folger, 1966; Cole and Cole, 1973; Gaston, 1978), it is often difficult to equate academic performance in general or scholarly performance in particular with quantitative measures of productivity. It has been suggested, for example, that citation to a scholar's work is a more valid measure of quality of publications, and it is often used jointly with publication counts as a measure of productivity (Long, 1978). Unfortunately, we have no such measure in the ACE data and the costs of gathering such information on so large and heterogeneous a sample are prohibitive.[2] In any case, citation count may well be more properly an index of collegial recognition (Reskin,

1977), a related but quite distinct concept. Also, it has often been observed that the quality and quantity of publication are highly correlated (Cole and Cole, 1967, 1973; Lightfield, 1971). Since sociologists of science have yet to specify a thoroughly reliable and valid measure of academic performance, we proceed with confidence in the use of this measure.

Background Characteristics. The gender, race, marital status and socioeconomic status background of scholars are included in the analysis to determine the overall effects of ascription and class advantage upon productivity and to control for such factors when assessing the relationships among academic variables in the full model.

In the absence of conventional measures of social standing, we utilize paternal and maternal schooling. It is not unreasonable to assume that the quantity of education of parents would affect the quality of the educational experiences for offspring. Marital status is added to the model as a measure of familial responsibility, a concept used by others to explain the observed differential productivity between sexes (Hargens, et. al., 1978; Reskin, 1978). The greater size of our sample relative to earlier studies permits us to examine the effects of racial differences upon the production of scholarly work. Age, an important nonacademic determinant of productivity (Meltzer, 1949; Dennis, 1956, 1966; Axelson, 1959), is excluded from the analysis. The academic characteristics of Years of Experience and Time to Ph.D. capture nearly all the variance in Age, and problems of colinearity among variables are therefore avoided. For statistical analysis, gender, race and marital status are treated

as dummy variables for which being female, nonwhite and married are each assigned a value of 1. Father's and Mother's Education are represented by the number of years of schooling each completed.

Academic Characteristics. The variables included here reflect several important concepts derived from the literature. As noted above, Years of Experience, estimated by the arithmetic difference between the year of the survey and the year a respondent obtained his or her doctorate, is used to assess the disparity of productivity over time. Since our data are cross-sectional and not longitudinal, we have no way of differentiating age, cohort and period effects in our analysis, though a synthetic cohort analysis might be undertaken. Academic Rank is an inherently ordinal variable and is used as such to avoid the loss of information entailed by coding it as a nominal measure. Tenure, however, is treated as a dummy variable, for which holding a tenured appointment is assigned a value of 1.

Measures of training are: holding a Ph.D. degree; the time it took to obtain this degree; and having received a Post-doctoral Fellowship. Ph.D. granted and Post-doctoral Fellowship are coded as dummy variables for which having held a fellowship and possessing a Ph.D. degree are assigned values of 1. Time to Ph.D. is estimated by subtracting the year the undergraduate degree was awarded from the year the doctorate was obtained.

Number of Grants, estimated by the number of funding sources from which a respondent received research support during the 12 months preceeding the survey, reflects the extent to which individuals rely upon

large capital expenditures and the resources associated with such funds in their research. Commitment to research is measured by the percentage of time an individual spends at teaching and research, number of journal subscriptions, and expressed commitment to research. Weekly Time at Teaching and Weekly Time at Research are measured by the respondent's estimation of the percentage of time devoted to classroom teaching and research activities during a typical week. However imperfect, these measures reflect variations in teaching load and the time available for research. Number of Journal Subscriptions is simply the number of journals the respondent reports subscribing to during the year of the survey. A Likert-type attitudinal scale has been included in the analysis to assess an individual's Commitment to Teaching. Responses to the following items were summed: "Teaching effectiveness, not publications, should be the primary basis for faculty promotion;" and "Institutional demands for doing research interfere with my effectiveness as a teacher." The degree of agreement with these items was measured on a five-point scale.

Finally, the characteristics of an individual's current appointment are measured by an index of the quality of the institution (as measured according to the Roose-Andersen (1970) scale for assessing institutional prestige) and the degree of agreement with the following item to determine the effects of institutional norms upon productivity; "In my department, it is very difficult to achieve tenure if one does not publish."

FINDINGS

Table 1 presents the means and standard deviations for the productivity measures, as well as background and academic characteristics

for the three disciplines. Because of the large size of the subsamples, virtually all differences in means presented in the table are statistically significant according to a series of one-way analyses of variance applied to each row. Therefore, our interpretations of observed differences must rest upon their substantive interest rather than simply on statistical significance.

The noteworthy differences in Table 1 pertain to article and book productivity across disciplines. As anticipated, Physical and biological

[Table 1 about here]

scientists far surpass both social scientists and humanists in mean number of articles, while social scientists publish articles at a rate nearly 60% greater than do humanists. Physical and biological scientists augment their impressive article production with a book publication rate of about 60% of that of humanists. Since social scientists exceed humanists in both book and article productivity, it cannot be plausibly argued that the latter's low productivity of articles is a consequence of the fact that books represent their preferred mode of research dissemination.

Regarding the background variables, the only important differences among the three disciplines is in the markedly higher proportion of women and the slightly lower proportion of married persons in the humanities. While the proportion of black academics is small for all three categories the highest percentage is found in the sciences (3.04), followed by the humanities (2.86) and social sciences (2.20).

Significant contrasts pertaining to the academic variables are drawn between the humanists, on the one hand, and the social scientists

and natural scientists, on the other. Humanists fall below those in other disciplines in terms of the number of grants received, the likelihood of having a Ph.D., the percentage of time spent on research, the likelihood of having received a post-doctoral fellowship, and number of journal subscriptions. Likewise, humanists spend more time on the average acquiring a Ph.D. and report slightly less pressure to publish in order to earn tenure.

Natural scientists report the highest percentage of their time devoted to classroom teaching (but the least commitment to this activity), as well as the highest percentage of time devoted to research. These findings imply less commitment to administrative duties and committee work on the part of scientists, since together teaching and research account for just over half the total time spent on academic duties. The scientists are also on the average more experienced and of higher rank. The large proportion of these individuals with tenure is probably due to their greater experience and the fact that on the average they spend less time acquiring a Ph.D.

Aside from the observation that natural scientists devote the greatest percentage of time to teaching, the data fit the prevailing stereotypes of academic scientists and humanists well. However, of more direct interest to this study is the extent to which nonacademic and academic variables influence research productivity, and the magnitude of the effect each has upon the production of articles and books. We now turn to this question.

Article Productivity: A Comparison. Table 2 presents standardized

and metric regression coefficients for article productivity regressed first on the background variables alone (equation 1) and then on both the background and academic variables (equation 2).[3] Separate analyses were conducted for the three disciplinary categories. From the structural

[Table 2 about here]

equations presented in Table 2 we may ascertain the direct effects of background, its indirect effects as mediated by the academic variables, and the effects of the academic variables when the influence of background is controlled. Relevant statistical tests for the presence of discipline main effects and interactions, as well as differences in the regression slopes across disciplines, are presented in Table 4. The Chow tests performed there indicate significant overall differences in slopes for both the article and the book count equations.

Our initial observation about Table 2 concerns the overall utility of our model in predicting article productivity for each of the three subsamples. Despite the size and heterogeneity of the sample, as well as the limitations imposed upon the model by the nature of secondary analysis, the full-form regression equations in Table 2 account for considerable variance in productivity among scientists (56%) and social scientists (45%), and still explain one-third of such differences for humanists. This observation assumes greater importance when our results are contrasted with much of the significant research in the field reviewed above.[4]

Closer examination of Table 2 reveals an extremely modest association between background variables and article count (equation 1). The nonacademic

variables explain less than 5% of the variance in article production for natural scientists and only about 2½% for social scientists and humanists. Nevertheless, all regression slopes significantly differ from zero in the reduced-form equations (marital status for social scientists being an exception).

With the addition of the academic variables to the model (equation 2), all of the coefficients associated with background variables become nonsignificant for social scientists, and all either become nonsignificant or are reduced in magnitude for the other two categories. This finding is important because much previous research on the topic by sociologists has utilized only academic variables as determinants of productivity. It is clear that the background variables bear only the most tenuous relationship to article productivity regardless of discipline. We can therefore discount the likelihood that systematic specification biases are present in analyses that exclude such factors. Given questions often raised about differential productivity between the sexes and the races, the finding that these two factors have no substantive influence upon article productivity in the presence of controls for academic career variables might be emphasized.[5] This finding is of singular interest in view of the fact that previous studies of productivity have, often by necessity, restricted their samples to white males.

Substantiating our initial hypothesis is the strong effect of the number of grants received among natural scientists, compared to its smaller impact for social scientists and humanists. It is interesting to note that while social scientists do not [illegible] far behind scientists in the mean number of grants received (see Table 1), the receipt of

a grant apparently results in greater article productivity for natural scientists than for social scientists.

Regarding other conditions of research, Weekly Time at Research has a relatively strong effect on productivity for all subsamples. Time at Teaching, however, has a significant effect only for humanists, and then its effect is positive, i.e. the greater the time spent at teaching, the greater the productivity. This surprising result is further supported by the positive and significant effect of Commitment to Teaching on article count for each subsample, confirming a widely held contention that productive scholarship does not preclude a devotion to or respect for teaching (Lewis, 1977).

As noted earlier, other studies of scholarly productivity have reported a moderate association between publication rates and the departmental or institutional prestige of the authors. For natural scientists our results are no exception: only Academic Rank and Number of Grants have a greater effect than Quality of Institution on article count. However, as hypothesized, among social scientists and humanists the relationship is considerably weaker, being overshadowed by three other factors (Experience, Number of Journal Subscriptions, and Weekly Time at Research). It would seem that the greater encouragement and support available for research at higher quality institutions is more important to natural scientists than other academics, since by its nature their research is more likely to be affected by the quality and availability of physical resources, personnel and collegial support.

Among early academic factors, Time to Ph.D., Post-doctoral Fellowship and Ph.D. Granted bear only weak relationships to article

productivity, with the exception of the moderate effect of Time to Ph.D. among social scientists. It is curious that despite the vaunted role of the Ph.D. as the essential academic, scholarly and scientific credential, when other determinants are controlled, its posession seems to confer no added increment to article productivity.

Regarding later career factors, Academic Rank strongly affects article count among natural scientists and social scientists, but not among humanists. As we shall see below, this pattern is nearly reversed for book productivity, supporting the contention that a stronger relationship between book productivity and advancement in academia exists for the humanities than for the sciences. Of course, it is possible that the relationship observed between rank and productivity is reciprocal. It is usually presumed, though by no means has it been convincingly demonstrated (see Lewis, 1975), that a modicum of publication is required for promotion, especially at more prestigious institutions. The cross-sectional data used here, however, are not well suited to determining direction of the causal relationship between these variables (see Long, 1978). We likewise observe that when other variables are controlled, unlike Years of Experience and Journal Subscriptions, tenure does not significantly affect article count. Once again, however, longitudinal data are necessary to substantiate any claim regarding the causal ordering between these variables.

Book Productivity: A Comparison. Table 3 presents regression equations comparable to those of Table 2, but here number of books published by individuals is the dependent variable. As was the case with article count, tests for disciplinary category interactions found in Table 4 are significant, indicating that overall differences in slopes are present.

Consistent with the assumption that books are a more important means for communicating the results of scholarly research for humanists,

[Tables 3 & 4 about here]

it can be seen that, while our model for article productivity accounted for the largest proportion of the variance among scientists, the equations in Table 3 explain the greatest proportion of the variance among humanists. The values of the coefficients of determination for productivity of books for social scientists, as was the case for productivity of articles, are intermediate between natural scientists and humanists.

In general, our model does a much better job of accounting for article than book productivity. As was noted above, among natural scientists, the subsample for which the model fits best, nearly 56% of the variance in article count was explained. At the same time, just 31% of the variance in book productivity is explained among humanists, the subsample for which the model fits best. Furthermore, among humanists 34% of the variance in article productivity is explained in Table 2, while just 14% of the variance in book count is explained among scientists. This clearly suggests that some major factors determining the production of books are not measured here.

A close examination of Table 3 reveals that, as was true with article count, only a small proportion of the variance in book productivity is accounted for by background characteristics, in this case little more than 1 or 2%. The relative unimportance of these variables to any theory of scholarly productivity is once again underscored.

As expected, the pattern of values for the regression coefficients is quite different in Tables 2 and 3. In particular, Number of Grants loses its preeminent importance for natural scientists and is replaced by Experience as the most important determinant of productivity. Its effect, however, is only moderate. The diminished effects of Quality of Institution, Weekly Time at Research and Academic Rank in the equation for natural scientists indicate that these dimensions are less important as determinants of book productivity, relative to their effect upon the publication of articles. The negative coefficient for Post-doctoral Fellowship and positive coefficient for Time to Ph.D. suggest that book productivity is more prevalent among less prestigious scientists; scientists not having received an award upon receiving their doctorates and scientists taking longer to earn a Ph.D. are more likely to be involved in book publishing.

Quite the opposite is the case for humanists. The effects of Quality of Institution, Academic Rank and Post-doctoral Fellowship are at least of equal importance to the production of books as to the production of articles. Thus, all things being equal, humanists who are of higher rank, recipients of an award, and/or who are employed at more prestigious institutions are more likely to have published books, but no more likely to have published articles. The diminished effect of Number of Grants on book count, relative to that on article count, underscores the independence of productivity and research funding in the humanities.

In contrast to the dissimilarities in the pattern of variables accounting for the productivity of books and articles among natural scientists and humanists, a striking feature of these equations for social

scientists is their similarity in accounting for the productivity of both forms of communication. While the overall predictability of the model diminishes for book production relative to article production for humanists (and vice versa for natural scientists), the contention of some that the two modes of scholarship are of roughly equal importance is supported only for social scientists. The principal exceptions to this generalization concern the effects of early career variables; Time to Ph.D. is positively related to book count, but negatively associated with article count, and Post-doctoral Fellowship simply has no effect on book count.

Process vs. Attribute: The Importance of Disciplinary Context. Thus far, we have shown that considerable variation in the process determining research productivity exists both across and within disciplinary categories. These findings suggest the need to explore more fully the importance of disciplinary context for productivity, i.e., how would a scholar's productivity be altered if he or she were in another discipline? To put the matter more precisely, what if a scholar possessing attributes typical of his or her discipline were subjected to the forces affecting productivity typical of another discipline?

In order to answer this question, we have assumed that the means of the predetermined variables (Table 1) characterize the "typical scholar" in a discipline, and the metric coefficients (Table 2 and 3) represent the way in which these variables influence productivity. By substituting the means for one sample in the regression equation for another, calculating an adjusted mean, and then comparing it to the appropriate unadjusted mean, we obtain an approxiate indication of the effect of membership in a

disciplinary category upon productivity. Table 5 presents the results of this adjustment procedure. The rhetoric used to describe the findings in

[Table 5 about here]

Table 5 should not be taken too literally. What we have done with this adjustment procedure might be described as nothing more than a "mental experiment." While it is difficult to conceive of a flesh and blood humanist in the sciences, or a social scientist in the humanities, we are interested in nothing more than shedding some light on the relative influence of composition (means) and context (slopes) on productivity, and expressing the findings in this manner is helpful to our understanding.[6]

Comparing these adjusted means to the unadjusted means of Table 1, it is evident that for natural scientists, it is the sizeable differences effects in the academic variables have on productivity that gives them such a decisive edge over social scientists and humanists in article production. Put another way, if the typical natural scientist were in the humanities, his or her research productivity would be much lower -- closer to that typical of the humanists. Likewise, were he or she in the social sciences, the social sciences average would be approximated.

On the contrary, for humanists it appears that it is their attributes that more decisively determine their lower rates of article productivity. Thus, a humanist subjected to the processes affecting scientists would produce a bit more than one additional article; subjected to the processes affecting social scientists, he or she would produce just one-tenth of an article more. However, a shift to the sciences regime would be beneficial for a humanist's book production, raising it by one book, while moving to

the social sciences would have no impact on book production.

A social scientist subject to the processes affecting a natural scientist would clearly benefit; article and book productivity would increase. A comparable shift to the humanities would yield mixed results for the social scientist's productivity; article productivity would actually decrease, while book productivity would be slightly enhanced. These results suggest once again that in the humanities the norms regarding productivity emphasize the importance of writing books rather than articles. More important, throughout academia, there are greater expectations that natural scientists rather than social scientists and humanists publish.

CONCLUSIONS

It is clear from our findings that a unitary model of scholarly or scientific productivity cannot be assumed to operate in all academic disciplines. Although background characteristics were shown to have only a minor influence on article and book productivity in all categories, the manner in which the features of individual academic careers and the conditions of academic work affect output are strikingly contrasted in the sciences and humanities. We have also shown that the mechanisms determining article and book count are quite different and are systematically related to the relative roles of the two forms of output in the broad disciplinary categories examined. Of particular importance is our demonstration that it is the way in which the academic characteristics of natural scientists are transformed into scholarly output rather than their superior ranking on those characteristics that results in their greater article count. These data neatly show that, independent of the volume of publication, the

process determining scholarly output depends upon the intellectual context of disciplines. Whether this more efficient translation of resources into output is the result of the more paradigmatic nature of research in the sciences or the reflection of a more universalistic stratification system -- a claim challenged by some recent research (Long, 1978; Long et al., 1979) -- cannot be resolved with these data.

One issue that our attempt at interdisciplinary comparison raises that is generally not salient to analyses focused on a single discipline is the influence of the social structure of publication systems on productivity. What constitutes an "article" (or even a "book") and the difficulty of getting one in print varies across disciplines and is not taken into account in our analysis. For example, as we suggested initially, the greater article productivity of scientists may in part be a function of the greater availability of journal pages and the higher acceptance rates of journals in the sciences (see Zuckerman and Merton, 1971). Likewise humanists are more likely to author book manuscripts that are treated by editors as trade publications addressed to a broad audience rather than as scholarly efforts, entailing a fundamentally different review process. In devising a measure of output that is comparable across disciplines, further research on productivity in academia must address this issue.

Despite the light our research sheds on (1) the factors affecting the production of knowledge, (2) the relative importance of the major forms of knowledge dissemination, (3) the utilization of available resources, and (4) the variability in the characteristics of early training among the sciences, social sciences, and humanities, such findings are useful only as a description of the features of a single instituiton --

academia -- in one society at a given point in time. To be more, it must be placed in a wider theoretical context. That context might be termed the "sociology of innovation," an integral component of the general study of social change. From this point of view, the modern university is viewed as just one organizational embodiment of the institutionalization of innovation in industrial societies. Publication count is simply one convenient measure of innovative behavior in this institutional setting. Problems of paramount interest are (1) how the organizational structure of the university and other research organizations, as well as the extra-institutional social structure, influence the rate of innovation and its production by individuals; (2) the processes that affect the formation of a community of innovators and shape its social structure; and (3) what factors influence the diffusion and recognition of innovations. Most of these issues have been addressed by sociologists of science in their research on discovery, publication, and the social structure of science. What we suggest is a broadening of this research effort to include innovation of a nonscientific nature produced in a variety of institutional settings. This is not to call into question the raison d'etre of the sociology of science, but rather to encourage the building of theoretical bridges across often isolated sociological specialties.

NOTES

[1]See Bayer (1973) for a detailed description of the ACE sampling and data collection procedures, the response rate, the weighting scheme used to adjust the data to population totals, and a thorough description of the questionnaire.

[2]It hardly needs to be said that secondary analyses such as this are rarely competely satisfactory. Important questions are too often misstated or altogether ignored, since those who initially gathered the data cannot anticipate future applications. There may not be measures for all of the factors one might believe are pertinent to the topic being examined. The absence of information is most apparent for these academic performance variables.

[3]Though we have chosen to report both the standardized and metric coefficients, we do not feel uncomfortable in making interdisciplinary comparisons using the standarized slopes or coefficients of determination, despite the conventional warning against such a practice (see Kim and Muller, 1976). As Hargens (1976) has suggested, under certain theoretical circumstances the standardized coefficients themselves should be viewed as structural parameters that can be readily compared across populations. For example, it might be plausibly argued that our estimate of the relative impact of a variable like number of grants on productivity ought to incorporate the fact that the means and variances of the two variables differ considerably across disciplines.

[4]Although samples are substantially smaller and more homogeneous,

and statistical models are considerably more refined, neither Reskin (1977, 1978) nor Long (1978) are able to account for more than 40% of the variance in productivity.

[5]The only exception is the marginally significant negative effect of being black on article count among scientists, though this, too, could disappear were our measures of the academic variables more refined or in the presence of controls for career contingencies not measured here.

[6]This distinction between individual attributes and disciplinary context may not in fact be as clear as our use of the adjustment technique represents it to be. Some of the characteristics referred to as attributes of individuals, such as number of grants, receipt of a post-doctoral followship, or time to Ph.D., may be strongly affected by disciplinary context or other external factors, such as the funding priorities of granting agencies. Nevertheless, we feel that the exercise does produce some insights useful in interpreting differences in productivity across disciplinary categories.

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Table 1. Means and Standard Deviations of Characteristics of Faculty by Disciplinary Category.

Faculty Characteristics	Disciplinary Category		
	Natural Sciences (N=6767)	Social Sciences (N=4186)	Humanities (N=6446)
Productivity Variables			
Books Published	0.89	1.80	1.44
	(1.80)	(2.61)	(2.41)
Articles Published	13.25	9.43	5.64
	(16.42)	(13.23)	(10.79)
Background Variables			
Sex	0.10	0.13	0.25
	(0.30)	(0.34)	(0.43)
Race	0.03	0.02	0.03
	(0.17)	(0.15)	(0.17)
Marital Status	0.84	0.85	0.75
	(0.37)	(0.36)	(0.43)
Father's Education	12.32	12.73	12.69
	(4.62)	(4.67)	(4.67)
Mother's Education	11.87	12.22	12.12
	(3.70)	(3.73)	(3.65)
Academic Variables			
Years of Experience	12.65	10.41	10.93
	(9.55)	(9.19)	(9.72)
Publication Norm	2.68	2.74	2.50
	(1.25)	(1.20)	(1.22)
Weekly Time at Teaching	25.71	21.57	24.41
	(14.74)	(10.95)	(11.99)
Number of Grants	0.49	0.40	0.12
	(0.78)	(0.70)	(0.38)
Time to Ph.D.	6.87	7.66	8.23
	(5.40)	(6.70)	(6.61)
Post-doctoral Fellowship	0.55	0.55	0.20
	(0.50)	(0.50)	(0.40)
Tenure	0.74	0.62	0.62
	(0.44)	(0.48)	(0.48)
Ph.D. Granted	0.67	0.62	0.51
	(0.47)	(0.49)	(0.50)
Academic Rank	2.93	2.83	2.62
	(0.93)	(0.98)	(1.05)
Journal Subscriptions	4.28	4.49	3.92
	(3.33)	(4.12)	(3.24)
Weekly Time at Research	27.21	25.76	21.28
	(17.90)	(15.87)	(15.34)
Commitment to Teaching	3.58	3.90	3.78
	(1.29)	(1.36)	(1.33)
Quality of Institution	4.95	5.04	4.61
	(2.36)	(2.38)	(2.44)

Note: Standard deviations are in parentheses. See text for definitions of variables.

Table 2. Standardized and Metric Regressions of Number of Articles on Faculty Characteristics.

Predetermined Variables	Disciplinary Category					
	Natural Sciences		Social Sciences		Humanities	
	(1)	(2)	(1)	(2)	(1)	(2)
Sex	-.090*	-.008*	-.120*	-.005	-.101*	.010
	(-4.91)	(-.417)	(-4.72)	(-.194)	(-2.54)	(.251)
Race	-.090*	-.021*	-.036*	-.003	-.048*	.000
	(-8.65)	(-1.99)	(-3.22)	(-.304)	(-3.10)	(-.032)
Marital Status	.128*	.047*	-.028	.017	-.076*	.049*
	(5.70)	(2.08)	(1.04)	(.626)	(1.89)	(1.23)
Father's Education	.082*	.020	.045*	.024	.082*	.046*
	(.291)	(.071)	(.128)	(.067)	(.190)	(.106)
Mother's Education	-.058*	-.035*	-.087*	-.016	-.066*	.018*
	(-.256)	(-.155)	(-.310)	(-.055)	(-.194)	(-.055)
Years of Experience		.147*		.214*		.147*
		(.253)		(.308)		(.163)
Publication Norm		.069*		.097*		.067*
		(.902)		(1.07)		(.593)
Weekly Time at Teaching		-.013		.018		.016*
		(-.015)		(.022)		(.015)
Number of Grants		.269*		.099*		.052*
		(5.66)		(1.88)		(1.50)
Time to Ph.D.		-.037*		-.116*		-.022*
		(-.113)		(-.230)		(-.037)
Post-doctoral Fellowship		.045*		.058*		-.012
		(1.48)		(1.55)		(-.327)
Tenure		-.010		-.006		-.020
		(-.366)		(-.160)		(-.458)
Ph.D. Granted		.015		.015		-.013
		(.515)		(.385)		(-.278)
Academic Rank		.251*		.323*		.033
		(4.44)		(4.33)		(3.44)
Journal Subscriptions		.131*		.105*		.161*
		(.646)		(.337)		(.536)
Weekly Time at Research		.152*		.141*		.167*
		(.140)		(.117)		(.118)
Commitment to Teaching		.040*		.040*		.065*
		(.512)		(.386)		(.530)
Quality of Institution		.174*		.102*		.097*
		(1.21)		(.565)		(.431)
R^2	.048	.558	.025	.451	.027	.335
Constant	8.69	-23.01	11.39	-19.35	4.87	-16.65
SEE	16.02	10.92	13.07	9.82	10.64	8.81

Note: All coefficients are ordinary least-squares estimates; metric coefficients (in number of articles) are in parentheses. See text for definitions of variables.

*Coefficients more than 1.96 times their standard error.

Table 3. Standardized and Metric Regressions of Number of Books on Faculty Characteristics.

Predetermined Variables	Disciplinary Category					
	Natural Sciences		Social Sciences		Humanities	
	(1)	(2)	(1)	(2)	(1)	(2)
Sex	.040*	.045*	-.090*	-.006	-.108*	-.014
	(.236)	(.268)	(-.694)	(-.046)	(-.601)	(-.081)
Race	-.001	.018	-.016	-.002	-.038*	.005
	(-.009)	(.191)	(-.292)	(-.038)	(-.544)	(.068)
Marital Status	.099*	.073*	.052*	.037*	.025*	.004
	(.480)	(.354)	(.379)	(.271)	(.139)	(.023)
Father's Education	.045*	.028	.006	-.009	.063*	.026*
	(.018)	(.011)	(.003)	(-.005)	(.033)	(.014)
Mother's Education	-.097*	-.054*	-.026	.041*	-.067*	-.009
	(.047)	(-.026)	(-.018)	(.029)	(-.044)	(-.006)
Years of Experience		.209*		.206*		.159*
		(.039)		(.058)		(.039)
Publication Norm		.025		.054*		.092*
		(.036)		(.116)		(.183)
Weekly Time at Teaching		-.012		.003		.014
		(-.002)		(.000)		(.003)
Number of Grants		.060*		.134*		.035*
		(.138)		(.501)		(.225)
Time to Ph.D.		.034*		.035*		.007
		(.012)		(.014)		(.002)
Post-doctoral Fellowship		-058*		.000		.025*
		(-.208)		(.002)		(.154)
Tenure		-.049*		.021		-.012
		(-.202)		(.111)		(-.061)
Ph.D. Granted		-.011		-.098*		-.101*
		(-.045)		(-.526)		(-.489)
Academic Rank		.099*		.249*		.372*
		(.192)		(.658)		(.855)
Journal Subscriptions		.129*		.077*		.073*
		(.069)		(.049)		(.054)
Weekly Time at Research		.008		.128*		.130*
		(.078)		(.021)		(.020)
Commitment to Teaching		.049*		-.001		.079*
		(.068)		(-.002)		(.143)
Quality of Institution		.062*		.072*		.107*
		(.047)		(.078)		(.106)
R^2	.014	.140	.016	.304	.019	.308
Constant	.806	-1.03	1.76	-2.73	1.63	-3.32
SEE	1.78	1.66	2.58	2.17	2.38	2.01

Note: All coefficients are ordinary least-squares estimates; metric coefficients (in number of books) are in parentheses. See text for definitions of variables.
*Coefficients more than 1.96 times their standard error.

Table 4. T-tests for Differences in Regression Coefficients between Disciplinary Categories and Chow Tests for Category Interactions.

Predetermined Variables	Comparison for Number of Articles			Comparison for Number of Books		
	Sciences/ Social Sciences	Sciences/ Humanities	Humanities/ Social Sciences	Sciences/ Social Sciences	Sciences/ Humanities	Humanities/ Social Sciences
Sex	-1.855**	-3.202**	1.347*	-.060	-.284*	.224*
Race	3.023*	3.531**	-.507	.033	.178	-.144
Marital Status	-.686	-2.213**	1.527**	.013	-.408**	.421**
Father's Education	.046	.006	.040	-.017	-.006	-.011
Mother's Education	.128	.108	.021	.028*	.006	.021
Years of Experience	-.028	-.215**	.187**	.063**	.039**	.024**
Publication Norm	.609**	-.234	.843**	.075*	.075*	.001
Weekly Time at Teaching	.151**	.040*	.111**	-.008**	-.006	-.002
Number of Grants	-3.215**	-2.779**	-.437	.504**	.190**	.313**
Time to Ph.D.	-.137**	.119**	-.256**	.031**	-.001	.032**
Post-doctoral Fellowship	1.252**	-1.740**	2.992	.153*	.187**	-.033
Tenure	-1.240*	-.027	-1.213*	-.308**	-.060**	-.248
Ph.D. Granted	-2.142**	-.828	-1.314**	-.217*	.089	-.306**
Academic Rank	.810*	-1.808**	2.618**	.451**	.384**	.067
Journal Subscriptions	-.355**	-.065	-.289**	-.018*	-.035**	.017
Weekly Time at Research	.013	-.064**	.077*	.011**	.017	-.006*
Commitment to Teaching	-.550**	-.312*	-.239	-.072	.016**	-.178**
Quality of Institution	-.607**	-.821**	.214*	-.017	.059**	-.076**
R^2 (saturated)[a]		.541			.302	
R^2 (additive)[b]		.504			.257	
F-ratio[c]		38.800**			31.032**	

Note: Coefficients reported in this table are those associated with the interaction terms in the saturated model, defined as the product of each predetermined variable and a binary variable for discipline.

[a]Proportion of variance explained by the saturated model, which includes the faculty characteristics, binary variables for discipline, and all interaction terms.

[b]Proportion of variance explained by the additive model, which includes only the faculty characteristics and binary variables for discipline.

[c]F-ratio for test of the null hypothesis of no discipline interactions.

*Slope difference significant at $p \leq .05$.

**Slope difference significant at $p \leq .01$.

Table 5. Average Productivity of Books and Articles after Adjustment for Mean Differences in Faculty Characteristics.

Average Productivity of:	Adjusted Mean Number of Articles	Adjusted Mean Number of Books
A humanist were he or she in the sciences	6.80	2.43
A scientist were he or she in the humanities	8.49	1.91
A social scientist were he or she in the sciences	11.95	2.84
A social scientist were he or she in the humanities	7.85	1.89
A scientist were he or she in the social sciences	10.47	1.58
A humanist were he or she in the social sciences	5.78	1.38

Note: See text for description of the adjustment procedure and Table 1 for unadjusted means for the three categories.